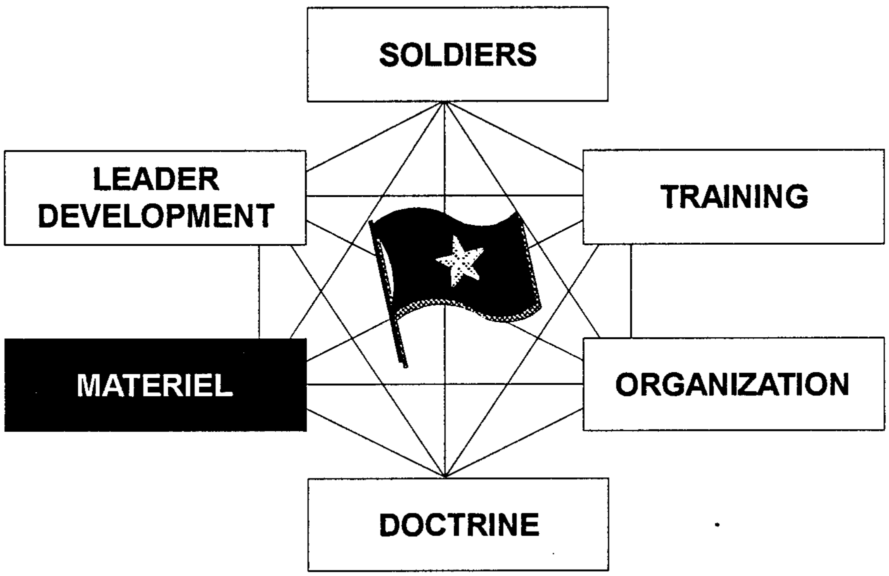
Information Technology in the Digitized Division



FY 95 Mobile Strike Force Battle Command Experiment

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November 1995

Introduction

Purpose. This paper presents observations, findings, and conclusions concerning the impact of information technologies on future battle command. This work supports the experimental work of the Battle Command Battle Laboratory - Fort Leavenworth (BCBL(L)).

Focus. The Training and Doctrine Command (TRADOC) Analysis Center (TRAC) addressed information technology issues as part of the overall analytical support to the Fiscal Year (FY) 95 Mobile Strike Force Battle Command (MSF/BC 95) Experiment, a subordinate study of the Prairie Warrior/Mobile Strike Force 1995 Advanced Warfighting Experiment (PW/MSF 95 AWE). The Mobile Strike Force (MSF) is a notional, division-sized force used by the Army to investigate Force XXI issues, to support building the future force. The relevant objective, issues, and essential elements of analysis (EEA) addressed in this investigation are shown below.

BCBL(L) Experimentation Objective

Explore requirements for information technologies to provide the command and staff team an adequate relevant common picture.

Relevant Study Issues

- How will battle command information technology capabilities (digitization) collectively affect division staff processes and organization?
- Does computer-assisted wargaming enhance integration of fire support and maneuver?
- Do fully integrated command, control, and intelligence systems better achieve a relevant common picture of the battlefield than "stove-piped" systems?

EEAs

- In addition to effects on situation assessment, what are the perceived contributions and challenges of the individual information technologies?
- What are the observed and perceived effects of computer-assisted wargaming on mission planning?
- In addition to the observed effects of the suite of information technologies, what are the perceived contributions of these collective, integrated capabilities?

Approach

Experiment Context

The BCBL(L) sought to emulate the knowledge-based environment envisioned as that relevant to Force XXI. The Command and General Staff Officer Course (CGSOC) Battle Command Elective (BCE) was used as the vehicle for experimentation. The BCE was developed jointly by BCBL(L) and CGSC. This course was jointly taught by instructors from the U.S. Army Command and General Staff College (CGSC), and the Army Research Institute (ARI) - Fort Leavenworth Field Unit. There were 73 CGSOC students in the 1995 BCE who were assigned to the command and staff of the MSF. An active duty general officer commanded the MSF.

The BCE students were trained through a holistic approach including classroom instruction, hands-on system training, one-on-one leader development sessions, and tactics, techniques, and procedures (TTP) development sessions. Further, there were three simulation exercises (SIMEXes) leading up to the culminating CGSOC exercise, Prairie Warrior (PW). The exercises were conducted using the Corps Battle Simulation (CBS) as the exercise driver. The information technologies were used throughout the SIMEXes, as an integral part of MSF operations.

The BCE students were required to use these technologies in this environment while learning the MSF concept, as well as a concept for division staff organization and process - the Digitized Battle Staff (DBS). This provided the MSF Commander quite a challenge, in addition to that faced by the students as the operators in this environment. Besides these two main concepts, the BCE students were also exposed to various aspects of the information operations (IO) concept throughout the course of the experiment. Although the analytic participants in the experiment had sought to control the number of variables, the introduction of multiple concepts occurred and was recognized by the MSF Commander as problematic.

Analytic Methodology

The analytic methodology focused on the data collection effort. There were several sources for data to answer the aforementioned EEAs. These were historical information, direct observation of the BCE during all the activities previously cited, and student surveys administered during the experiment. Direct observation was enhanced by help from the Operational Test and Evaluation Command (OPTEC), which augmented the TRAC study team during the SIMEXes and PW. These observations were the principal means to evaluate the technologies and to develop further requirements for the future battle command system. The information collected was used to compare the information technologies, both to each other, and to other government and commercially available systems. There was no readily observable baseline information technology system for comparison.

A survey assessed the technological literacy of the BCE students. The results of this survey provided insight into why and how the students operated in the environment as they did, and identified further challenges regarding information technologies. A survey also addressed the importance and difficulty of acquisition of the acknowledged leader competencies. Included among them is the use of available systems, which directly relates to the assessment of the information technologies. A third survey addressed the individual and collective effects of the suite of systems providing situational awareness to the MSF, and the contribution of computer-assisted war-gaming.

Experiment Information Technology Systems

The systems discussed in this section are categorized as either protoype or actual battle command support systems, and training simulation support systems.

Battle Command Systems

Phoenix. The Phoenix system was a developmental software package used as the MSF battle command decision support system (BCDSS). The Phoenix software package ran on a

SUN SPARC 20 workstation under the UNIX operating system. Phoenix required a local area network (LAN) and associated software to complete the required workstation connectivity and DBS architecture. Phoenix was essentially a surrogate for an upgraded Maneuver Control System (MCS). Software development continued throughout the experiment. The varied changes which occurred, although enhancements for the most part, were the source of much disruption to the student training, and to MSF planning and execution during the experiment. Phoenix was operated by the BCE students. The salient capabilities and characteristics are shown in the box.

- digital mapping
- graphics package to develop operations overlays
- database management system to handle large databases containing all the force level information
- electronic mail to allow work stations to inter-communicate
- videoteleconferencing (VTC) to allow virtual collocation between staff cells
- collaborative graphics package (whiteboard) to permit digital interactive collaboration
- word processing

ASAS Warrior. The All Source Analysis System (ASAS) Warrior workstation was provided to the intelligence processing section of the MSF staff to perform the intelligence collection and analysis functions. ASAS Warrior provided via LAN to Phoenix the location and status of all enemy forces identified through the intelligence cycle. The ASAS Warrior software also ran on a SUN SPARC 20 workstation under UNIX and required a LAN and associated software for workstation connectivity. This system required dedicated system operators who came from the Intelligence School to support the experiment. This system provided the capabilities shown in the box.

- basic map background
- database management system to collate, sort and analyze intelligence data
- graphics package to permit the construction of control measure graphics overlays for the map background
- electronic mail/file transfer routine to permit the transmission of intelligence databases to other elements

AFATDS. The Advanced Field Artillery Tactical Data System (AFATDS) was provided to the field artillery elements of the MSF staff to perform fire support planning, control, and execution functions. AFATDS software also ran on a SUN SPARC 20 workstation under UNIX or a MILTOPE computer. AFATDS required a LAN and associated software for workstation connectivity. This system required dedicated system operators who came from the Field Artillery School to support the experiment This system provided the capabilities shown in the box below.

- basic map background
- graphics package to permit the creation of control measure graphics overlays for the map
- database management system to provide the capability to receive, sort, collate, and prioritize target information, and to transmit that information to firing units in the form of fire missions
- electronic mail/file transfer routine to permit the receipt and transmission of target information

FAADC2I. The Forward Area Air Defense Command, Control, and Intelligence (FAADC2I) system was provided to the air defense elements of the MSF staff to perform planning, coordination, and execution functions of air defense fires available to the MSF. The FAADC2I software also ran on a SUN SPARC 20 workstation under UNIX or a MILTOPE computer and required a LAN and associated software for workstation connectivity. This system required dedicated system operators who came from the Air Defense School to support the experiment. This system provided the capabilities shown in the box.

- basic map background
- graphics package to permit the creation of control measure graphics overlays on the map
- database management system to provide the capability to receive, sort, collate and prioritize air defense target information and to transmit that information to firing units
- electronic mail/file transfer routine to permit the receipt and transmission of target information

LAD. The Logistics Anchor Desk (LAD) was provided to the logistics elements of the MSF staff to perform planning, coordination, and execution functions associated with logistical operations in support of the MSF. LAD software also ran on a SUN SPARC 20 workstation under UNIX and required a LAN and associated software for workstation connectivity. This system required dedicated system operators who came from the Logistics Center to support the experiment. This system provided the capabilities shown in the box.

- basic map background
- graphics package to permit the creation of control measure graphics map overlays
- database management system to provide the capability to receive, sort, collate, account for and prioritize logistics information, and to transmit that information to logistics units
- electronic mail/file transfer routine to permit the receipt and transmission of logistics information
- limited modeling to permit the examination of various logistics support scenarios

TEM/OPS. The Engineer School provided the Terrain Evaluation Model/Obstacle Planning System (TEM/OPS) to the MSF engineer and all brigade headquarters to perform detailed terrain analysis and to support engineer planning, coordination and execution. The TEM/OPS software ran on a UNIX based SUN SPARC 20 workstation and required a LAN and associated software for workstation connectivity. System operators from the Topographic Engineering Center supported the experiment, although BCE students also operated the system. The TEM/OPS system provided the following capabilities:

- high quality digital mapping and geographic information system that permitted the conduct of detailed, multi-faceted, terrain analysis
- graphics package that permitted the creation of control measure graphics and obstacle planning overlays for the terrain displays
- electronic mail/file transfer routine that permitted the receipt and transmission of terrain and graphics information
- planning tool that permits the comparison of engineer resource requirements with capabilities, conducting resource allocation and prioritization of work effort, generating logistics resource requirements

NET. The Network Evaluation Tool (NET) was provided to the signal section of the MSF staff to perform communications network planning and network analysis. The NET software ran on a DOS-based personal computer (PC) as a stand-alone system. The two BCE signal officer branch students were trained by the Signal School to use the system. The NET provided the following capabilities:

- digital map background
- graphics package that permits the creation of control measure graphics overlays for the map
- communications network assessment tool that permits the evaluation of communications node connectivity based upon terrain location and masking, communications network loading, communications network connectivity and routing

OPLOG Planner. The Operations Logistics (OPLOG) Planner was provided to the logistics elements of the MSF staff to perform logistical planning, coordination and execution functions. The OPLOG planner provided the capability to create detailed force organizations and structures and to develop detailed logistics resource requirements for various operational scenarios. This software program ran on a DOS-based PC. CGSC logistics instructors trained student users.

LPXMED. The stand-alone Logistics Processor Medical (LPXMED) model was provided to the medical support staff of the MSF to perform planning, coordination and execution functions associated with medical operations in support of the MSF. The LPXMED provided the capability to create detailed force structures, and to develop and evaluate medical support requirements, patient treatment and evacuation plans, and personnel return-to-duty estimates based on various operational scenarios. This software program ran on a stand-alone DOS-based PC. Medical Service School personnel trained student users.

Training Simulation Systems

CBS. The Corps Battle Simulation (CBS) provided a basic map background and a computer force-on-force simulation to drive the SIMEXes and exercise Prairie Warrior. It consisted of numerous user functional area terminals connected to a central computer system. It permitted users to execute maneuver, fire support, army aviation, air defense, engineer, logistics, and intelligence functions to simulate a division-sized combat organization executing a warfighting scenario. CBS was joined with other functional simulations during PW to form the Confederation of Models (COM) and increase the scope and fidelity of the exercise environment.

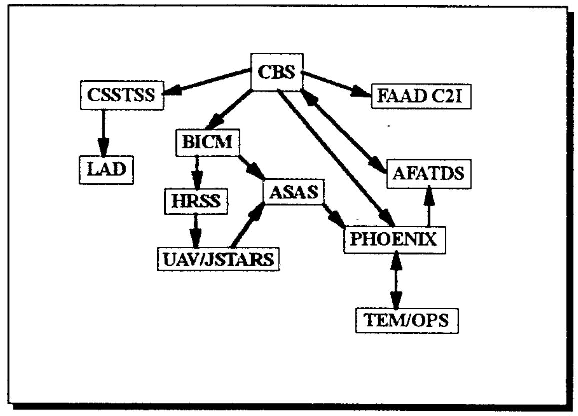
BICM. The Battle Command Training Program (BCTP) Intelligence Collection Model (BICM) was a software program that used unit location databases and computer algorithms to represent intelligence sensor capabilities to develop the perception databases on opposing forces in CBS. BICM output was used as input to the ASAS Warrior workstations to represent intelligence feeds to the Analysis and Control Element (ACE) of the MSF military intelligence (MI) battalion.

UAV/JSTARS/HRSS. The Unmanned Aerial Vehicle/Joint Surveillance Target Attack Radar System/High Resolution System Simulator (UAV/JSTARS/HRSS) was provided to the aviation, field artillery, and intelligence staffs, and to the maneuver brigades of the MSF to perform reconnaisance and target acquisition functions. This system simulated the feeds from UAVs and JSTARS to provide realistic UAV and JSTARS sensor imagery to system operators in their respective staff sections. The software ran on a networked array of MicroVAX, SUN

SPARC 20, and Silicon Graphics computers which required a LAN and associated software for simulation station interconnectivity and connectivity to the CBS exercise driver. This system required dedicated system operators who came from the Battle Command Battle Laboratory - Huachuca (BCBL (H)) to support the experiment.

CSSTSS. The combat service support/training support system was a hardware and software interface system that took low resolution CBS combat results and logistics output, and translated them into detailed logistics consumption data and support requirements. CSSTSS then fed the detailed information to LAD and other logistics support information technologies. This interface system was required to make the logistics functional area technology systems work.

Connectivity. The figure in the box shows the degree of connectivity that existed among the information technologies. One-way feeds (indicated by single-headed arrows) did not allow interaction with the exercise driver (CBS).



Availability. The information technology systems described above comprised the knowledge-based environment in which the BCE operated. However, the information technology systems were not all available throughout the entire experiment. The FAADC2I system was not available until the second SIMEX. The UAV/JSTARS/HRSS was not available until the third SIMEX. LAD, although available prior, was not functional until PW when the CSSTSS interface came online.

Observations and Findings

Materiel

Generally, the information technologies examined were stand-alone, stove-pipe systems designed to support specific functional areas. Because most of them had not been previously integrated into the Army Battle Command System (ABCS), this integration was a challenge during the experiment. The lack of a totally seamless ABCS environment was a factor behind most shortcomings of the battle command system as a whole.

Hardware. The Army requires the UNIX-based open system achitecture operating environment as the common operating environment (COE) for all Army tactical computer information systems. The SUN SPARC 20 is the chosen platform for this operating environment. This type of hardware provides very powerful computing platforms, but it is expensive relative to PC-based systems and learning to operate in the UNIX environment was observed to be difficult for many of the BCE students.

Software. Most of the software packages examined lacked user friendliness. Many of the programs required users to go through multiple, layered menus to perform even the most simple of tasks. Many of the Phoenix menu selection options did not appear to be intuitive to most of the BCE users. Most of the database queries demanded a user to be familiar with structured query language (SQL), building database queries with Boolean logic operations to successfully exploit the database management system (DBMS). As shown in the table below, the technology literacy self-assessment indicated that the BCE would likely have some problems with a difficult DBMS. There was some improvement indicated by the re-assessment (second row), which the study team also observed during the experiment.

	Totally Illiterate	Some Familiarity	Competent	Very Comfortable	Totally Literate	Mean of 1-5 Scale
DBMS	17	32	15	8	1	2.23
	11	26	18	13	5	2.66

Solutions developed to software problems during the experiment tended to be technically oriented in their implementation. Indeed, the Phoenix system itself could be characterized as a very programmer-oriented system at the time of the experiment. Partly because of this fact, the computer programmers on the contract support staff usually had much less difficulty than the users did with the software. However, this experiment reinforced the requirement that user (with the user appropriately characterized) friendliness be built in and maintained.

The software packages examined usually operated in an *X-Windows* environment under UNIX. This is a very powerful open architecture operating environment and is widely used to support scientific and complex business applications. This environment is preferred by many computer programmers - its power can be very helpful in developing solutions to highly technical problems. However, *X-Windows* is fairly complex, requiring a large investment in education and training to gain and maintain users' proficiency. When users were thrown out of an application into *X-Windows* or UNIX they were usually lost logically and could not recover. An easier, simpler, and more widely accepted operating environment (such as a DOS-based Windows environment) should be considered in part to allow most users to more readily recover from failures. The technological literacy survey supported this view. As shown in the table below the BCE students assessed themselves as much more competent with Windows and DOS than with Unix. The first row of the table associated with each operating system presents the results of the first survey, while the second row presents the results of the re-assessment. The BCE seemed to have some positive effect on the students' UNIX competency, but still just over twenty percent believed themselves competent or better at the end of the course. This is a reflection that there was not training in UNIX, per se, but the familiarization with it from required usage throughout the experiment. The results of the re-assessment regarding Windows provide strong support to consider the use of that type of operating system or operating environment as the COE base.

	Totally Illiterate	Some Familiarity	Competent	Very Comfortable	Totally Literate	Mean of 1-5 Scale
Windows	3	19	20	20	11	3.23
	0	9	21	18	24	3.63
DOS	6	28	18	12	9	2.86
	1	21	18	24	9	3.26
Unix	47	20	4	1	1	1.48
	31	27	8	7	0	1.88

Networks and communications. Users experienced many problems related to the network and communications throughout the experiment. BCE students had difficulty understanding the network and developing familiarity with it. The experiment reinforced the need for a division-level LAN/WAN manager and staff. The apparently complex network that serviced Phoenix proved to be inadequate. The network was created by establishing one workstation in each cell as the server for that group, which were then linked together. The network was not specifically designed, equipped, and managed to support the MSF in the experiment. The network was inadequate to handle the communications load placed on it. The network became saturated frequently and resulting data collisions interrupted MSF communications. A VTC capability on Phoenix via the network allowed virtual collocation and collaboration. However, the network frequently ground to a halt during the use of VTC. Use of the VTC also locked up the network and prevented users from performing any other functions on their workstations that required network access. Phoenix also allowed an interactive graphics capability called a whiteboard. The whiteboard allowed network users to share graphics interactively via VTC. This particular capability facilitated the dissemination of the MSF Commander's relevant common picture and intent to the MSF command and staff. The whiteboard provided each networked user a different color light pen to draw on the base picture. Because the video portion of the VTC consumed so much of the network capacity, the MSF adopted the standard operating procedure of turning off video and making the conferences audioteleconferences (ATCs). These ATCs relied on the whiteboard with a common map background to enhance collaboration. There were still periods when the network could not simultaneously support the ATC with whiteboard and basic Phoenix functions. During several ATCs, audio communications deteriorated so badly that conference participants reverted to using handheld radios for the audio portions of the conference.

The network linkages between the separate systems were also inadequate. Large volumes of data were exchanged between those systems which were connected. Megabyte sized database transfers and file updates were not unusual. The network usually slowed noticeably when supporting these operations.

A telephone system was available because of the lack of normal tactical communications systems in the experiment. It had a conference call capability, but the capability was little used in the conference call mode because it limited participants to those specific individuals listening to the phone conversation. There were speaker phones in the cells, but the noise level of the cells made them difficult to exploit because users could not turn off voice transmission microphones to only listen. All cells' noise was potentially heard over the conference line. Motorola handheld radios provided a capability to transmit immediately one to many and served as backup to the audio portion of the ATC when that broke up on the computer network. These also provided a capability for many to listen in on the conversation between two participants. This proved a valuable redundant communication means for the MSF.

The results of the technology literacy survey indicated the BCE experience raised the competency of students in the two collaborative technologies, as shown in the table below. The number of students rating themselves as competent or better with VTC almost doubled. The number of students making an assessment of competency or better in comms (representing PC communications packages and other communications (network) technologies with which the students were familiar) increased over fifty percent, with over twenty percent of the BCE moving into these three top categories.

	Totally Illiterate	Some Familiarity	Competent	Very Comfortable	Totally Literate	Mean of 1-5 Scale
VTC	25	29	10	6	3	2.08
	5	31	24	11	2	2.64
Comms	13	29	16	12	3	2.49
	4	21	21	20	7	3.07

The study team also conducted an *ad hoc* survey of ten BCE students during PW. The subject of the survey was local area networks (LANs), wide area networks (WANs), and the Internet. The students were asked to assess their knowledge of LANs, WANs, and the Internet, their comfort with each, and the frequency of their usage of each of them. The ten students all had an opinion about these technologies and believed they could evaluate them. On a five point scale, the mean response regarding knowledge of LANs was 2.9 - close to "medium" knowledge. The mean response for knowledge of WANs was much lower at 1.7, falling between "none" and "minimal;" in fact, only one respondent indicated a knowledge level of WANs above "minimal." The mean response for knowledge of the Internet was 2.6 - between "minimal" and "medium." With regard to comfort, for LANs and the Internet, the mean responses were 2.6 and 2.7, respectively, falling between "can use with help or presets" and "can use independently with effort." Students were less comfortable with WANs, with a mean response of 1.6, between "never done" and "can use with help or presets." Eight of the ten respondents indicated their frequency of internet usage was in one of the three lower categories, with a mean response of 2.6, between "only for exceptional reasons" and "occasionally." None of the ten students identified themselves as regular Internet users. The results of this survey further indicate the level of the challenge to raise awareness and competency in fundamental knowledge-based force technologies.

Specific Battle Command Systems. This section presents observations concerning the individual battle command systems.

Phoenix. The Phoenix system was available throughout the experiment. Study team members received two hours of familiarization training and observed two student groups each receive six hours of hands-on system training. The students were observed for more than 150 hours operating the Phoenix systems during the three SIMEXes and PW. The following observations, related to specific Phoenix capabilities are based on this experience.

a. Common scalable map displays. The Phoenix mapping capability, although good, lacked the robustness of a true geographic information system (GIS) for the following reasons:

- lacked complete high resolution digitial terrain coverage
- lacked ability to scroll across terrain
- lacked capability to show data in all map scales
- lacked ability to perform the spectrum of terrain data processing

• lacked ability to import and use other than Defense Mapping Agency (DMA) digital terrain data
• lacked adequate screen display on most workstations (due to size)

b. Enemy and friendly force tracking. This capability, as demonstrated, was based on CBS feeds. The timeliness of the information updates was often lacking. These were frequently one-half to more than two hours old, because of LAN backlogs of database updates during the exercises. Updates were not continuous, but at designated time intervals. Both enemy and friendly unit database updates were performed every five minutes at the beginning of the SIMEXes, but that was later changed to every 15 minutes because the LAN could not handle the data loading. However, discussions with BCE students revealed that most of them believed the systems provided enhanced situational awareness relative to current systems. This may be partly based on the proliferation of large screen displays throughout the MSF. Thirty-seven inch monitors and a 60 inch monitor were provided during the experiment with Phoenix. These displays enhanced staff collaboration, by providing large enough digitally based views of the battlespace that multiple commanders and staff could view simultaneously. Essentially, it was possible to provide a somewhat detailed view of the MSF's "big picture," which in this case was an extended 300 kilometer long by 150 kilometer wide battlespace. There was some apparent ambivalence regarding an overall assessment of the system. This ambivalence is revealed in part by the results of the effects survey, shown below. The specific survey question asked is also shown. The first row with each respective system characteristic reflects the results of the first effects survey (post-first SIMEX), while the second row shows the results of the re-survey (post-third SIMEX). A careful examination shows that speed improved, but that neither timeliness nor quality improved significantly. This indicated the developmental system may have become more efficient, but that it did not become more effective for battle command in the MSF.

◆ Assess the effect of the situational awareness tools (e.g., integrated in Phoenix or ASAS) on the timeliness, speed, and quality of situation assessment as you observed it in the exercise.

Timeliness	Very Untimely	Somewhat Untimely	So-So	Reasonably Timely	Very Timely	Can't Evaluate	No Opinion
	4	26	18	17	3	4	1
	6	16	23	16	6	6	0
Speed	Very Slow	Somewhat Slow	So-So	Reasonably Fast	Very Fast	Can't Evaluate	No Opinion
	6	23	25	12	1	5	1
	6	16	20	24	3	4	0
Quality	Very Poor	Somewhat Poor	Mediocre	Reasonably Good	Very High	Can't Evaluate	No Opinion
	2	11	25	27	3	4	1
	4	6	29	27	3	4	0

c. Dynamic distributive overlays. This capability permitted users to draw operational graphics on the common scalable map displays and transmit those overlays to other user stations via LAN. Creating the overlays was cumbersome using the menu driven graphics package, taking up to five separate menu selections to draw a line. Once that operation was complete it took another five menu selections to draw another line. The method of distributing the graphics files was by e-mail via the LAN. This method was slow and cumbersome to use, the menu selections were not logical, and distribution could not be made to groups (one-to-many concept). E-mail messages had to be sent to each individual work station, contributing to network overloading.

d. Voice activation. A voice recognition software program running on a 486 processor-based personal computer was made available to the MSF. It was connected with many of the Phoenix workstations. This program required users to speak into a headset/microphone to calibrate the software to the user's voice patterns. This process took approximately 45 minutes for each user on a machine. The users could then issue voice commands corresponding to the menu selections to execute the Phoenix operations. This system seemed to work fairly well, but it was not readily accepted by users. Users expressed concerns about the length of time required to calibrate the system, the awkwardness and rigidity of the command structure (and menu selections), and the tethering of personnel to a computer with a hardwired headset that limited personal mobility. The system did not work well in PW because of the higher levels of activity and the increased levels of background noise. The system included the capability to adjust to varying levels of background noise, but students received no training on how to make these adjustments.

e. Interactive graphics. This capability was accomplished through the whiteboard - a software program. This permitted users to join a conference on the network as a VTC, but using only the white board. The conference participants could individually and in turn bring graphics (usually maps and overlays) into the whiteboard, where all could then see and share the same picture. Each participant could then use seperate mouse-driven colored markers to draw on and highlight entities on the shared picture. This feature worked very well and was exploited extensively for virtually-collocated command and staff collaboration.

f. 3D visualization. This feature permitted users to create a 3D view of the terrain from a reference point outward. These were individual snapshots and were useful to gain topographic awareness. However, it was not observed to provide the level of detail needed for tactical operations planning. Also, the tool could not be used to develop "fly-through" sequences.

g. Course of action (COA) analysis tool. This feature never worked. A tool was planned to provide movement planning; provide force ratio calculations for all engagements; and provide screen captures of each phase of each COA to use to develop branches. An automated wargaming capability is required that will resolve force engagements and allow screen and data captures that will present a history of force engagements so that they may be quickly analyzed. Force ratio calculations do not provide reliable battle outcomes or help to identify other synchronization problems.

h. OPORD generation tool. This feature was to generate a graphical operations order. It was to dynamically link to other system tools, executables, and voice files. Also, it was to use the CECOM OPORD generation tool with some enhancements to expedite the order generation process. However, this latter feature never worked, nor was it demonstrated. The operations orders that were generated by the MSF were graphical with supporting linked text blocks.

i. Synchronization matrix. This feature was to link events from the wargaming process to execution tools such as the decision support template, event template, and others. This feature never worked as intended. As implemented it merely transferred the synchronization matrix development process from paper to electronic media. It was very complex and user unfriendly. It took up to nine menu selections to put each label on a matrix column or row. With up to 50 labels needed on a matrix, it was quicker and easier to do it by hand on a preprinted form.

j. VTC. The videoteleconference capability permitted multiple users to join a VTC with real-time, interactive video and audio. This capability was to be used for command and staff collaboration, but was ineffective because of the inability of the network to handle the data volume. Most conferences were reduced to ATCs. Sometimes the data loading was even too great for the ATCs, as data collisions caused breakups in the voice transmissions. The results of the technology survey are shown again below. These indicate the effect of the BCE experience with regard to VTC literacy. They show a significant increase in student competency, although just over half assessed themselves as competent or higher at the end of the course.

	Totally Illiterate	Some Familiarity	Competent	Very Comfortable	Totally Literate	Mean of 1-5 Scale
VTC	25	29	10	6	3	2.08
	5	31	24	11	2	2.64

Many other general observations were made during the experiment. User training was inadequate. The system was too complex to achieve competency during the limited training period. Further, this period did not even permit adequate familiarization with the system, so as to gain competency through self-development. There were several factors contributing to the training difficulties. One factor was the requisite reliance on the multi-layered menu system. A second factor was the required use of SQL. A third factor was the lack of simple, familiar office automation programs for word processing, graphics, database management, spreadsheet, and e-mail. As shown by the results of the technology survey in the table below, the BCE students

	Totally Illiterate	Some Familiarity	Competent	Very Comfortable	Totally Literate	Mean of 1-5 Scale
Word Processing	1	8	22	24	18	3.68
	0	5	14	34	20	3.95
Graphics	4	14	21	24	10	3.3
	0	10	16	33	14	3.7
Spreadsheet	18	24	18	8	1	2.42
	6	25	20	16	6	2.88
DBMS	17	32	15	8	1	2.23
	11	26	18	13	5	2.66

assessed themselves highest in word processing and graphics, which are standard office applications proliferated throughout the Army. Because of this, programs of this type in Phoenix would likely have enhanced the usefulness of the system. The ability to associate text with graphics was limited to electronic "post-it notes," which had many technical problems and were awkward to use. At one point, over 300,000 post-it notes were attributed to one student. E-mail was also overly problematic relative to the state of the technology. As an example, during the experiment routine, e-mail text messages inexplicably reproduced in the system, hidden from and unknown to users. At one time, over 3,000 e-mail messages were backed up in one mail box. This backlog was due to the problem of transparent replication of messages. A fourth factor contributing to the training difficulties was the lack of standardized file names which resulted in overwritten files and lost data, which even occurred while programmers were using the system.

A print capability was not developed for Phoenix until late in the experiment because BCBL(L) was exploring the concept of a "paperless TOC." Hardcopy output was needed for reference and collaboration, and as a backup to electronic media. There was no initial capability to download or backup user files. This and the inability to print caused the students to recreate complete sets of plans and orders and the associated graphics on at least three separate occasions when data were lost because of system and network problems. The idea of a "paperless TOC" was thus demonstrated to be on the wrong track. The maximization of electronics, as opposed to the complete elimination of paper, was demonstrated to have merit.

<u>ASAS Warrior</u>. The ASAS system provided the basic required intelligence functionality. ASAS ran on hardware common with Phoenix and was driven by multiple menu layers. This system required users to be knowledgeable in both SQL and UNIX. The system received intelligence sensor feeds from the CBS model via BICM. These data were sorted into databases by sensor discipline. Intelligence analysts collated and analyzed the data and developed an enemy picture. An updated intelligence picture was transmitted throughout the MSF and used to plan and monitor operations. The transmission of the intelligence updates was accomplished through database updates of the enemy situation. These updates were planned to occur every five minutes, but because of the volume of data required to be transmitted and the design of the LAN, the update interval was changed to every fifteen minutes. The data were current in these updates, to the precision of the interval. This increased interval still created problems during PW because

of increased organizational activity and corresponding increased data usage on the LANs. Intelligence update backlogs sometimes ran as high as two hours and the staleness of this information adversely affected the staff throughout the experiment. The uncertainty as to how fresh near-real-time information actually was disrupted the MSF staff on several occasions, but the freshness problem was somewhat mitigated by their increasing awareness of it. This problem was mainly related to the network and configuration of systems in the experiment, as opposed to the ABCS concept. Information within the ASAS databases was detailed and original data were time-tagged, but accessing this information required a high skill level. ASAS Warrior workstations required the dedicated operators provided who were trained in specific intelligence disciplines and the system hardware and software. User friendliness was lacking, but was mitigated by the dedicated support. The results of the surveys regarding the effect of the suite of battle command tools on the intelligence BOS are shown below. The intelligence BOS results are predominantly an indication of the effect of ASAS Warrior, because of the proliferation of the information from this system throughout the MSF. There was some shift of respondents into the positive categories. The BCE was generally pleased with enemy situational awareness during the course of the experiment, primarily because they were provided much more information on both enemy and friendly forces than systems they had used provided to them.

	Very Negative	Somewhat Detrimental	Neutral	Reasonably Positive	Very Positive	Can't Evaluate	No Opinion
Intelligence	2	11	17	29	4	10	0
	2	11	13	32	9	4	2

AFATDS. AFATDS provided the basic required fire support functionality. The map background was a piece of featureless terrain. Although it may be backed up with digital data, the general terrain picture was a white or beige background superimposed with grid lines and control measure graphics. The DBMS commands were either menu or manually entered. AFATDS was cumbersome and did not provide the required data entry flexibility. For example, when a target was identified on the display screen, the operator had to manually enter the grid coordinates instead of clicking on that location with a mouse and entering those coordinates into the AFATDS fire mission format. When a fire mission was repeated, all targeting information must be entered manually for each data element required on the fire mission work menus. There was no copy and paste capability. Thus, user friendliness was lacking. The results of the effects surveys regarding the effect of the suite of battle command tools on the fire support BOS are shown below. This is presented to provide an indication of the effect of AFATDS on the fire support BOS. There was almost no change of respondents regarding fire support. The responses related to fire support indicated that the BCE was generally pleased with support to fire support during the experiment. Observations revealed nothing to the contrary to this indication with regard to AFATDS in the experiment.

	Very Negative	Somewhat Detrimental	Neutral	Reasonably Positive	Very Positive	Can't Evaluate	No Opinion
Fire Support	0	12	18	23	4	14	2
	3	11	18	25	4	9	3

FAADC2I. The FAADC2I system provided basic air defense C2 functionality. The FAADC2I map background was a piece of featureless terrain. Although it may be backed up with digital data, the general terrain picture was a white or black background with grid lines and control measure graphics superimposed on it. The DBMS commands were either menu or manually entered. It was cumbersome and not designed for maximize efficiency or operator effectiveness nor did it provide the flexibility needed for multiple data entry methods. There was no copy and paste capability. Again, in general, user friendliness was not a strong point of the system, but it was better than some other systems. The results of the effects surveys regarding the effect of the suite of battle command tools on the air defense BOS are shown below. This is presented to provide an indication of the effect of FAADC2I on the air defense BOS. There was some shift of respondents out of the negative categories. The responses related to air defense indicated that the BCE became much more pleased with support to this BOS over the course of the experiment. Observations revealed nothing to the contrary to this indication with regard to FAADC2I in the experiment.

	Very Negative	Somewhat Detrimental	Neutral	Reasonably Positive	Very Positive	Can't Evaluate	No Opinion
Air Defense	5	13	14	6	1	32	2
	3	9	21	13	1	17	9

LAD. LAD required the CSSTSS interface with the CBS system to generate the logistics data for the LAD. The LAD was not functional until PW, but was on hand in the first SIMEX. This was primarily because the CSSTSS interface was not available until PW. Although LAD permitted the detailed tracking of supplies, it did not provide any feature to permit the users to forecast logistics requirements. Data mismatches among the CBS, CSSTSS, and LAD systems plagued LAD throughout the experiment. The results of the effects surveys regarding effects of the suite of battle command tools on the CSS BOS indicate the extent to which the lack of integrated logistics tools affected the experiment. Over 90 and 80 percent (first and second survey) who rated the effects on the BOS in the two surveys, rated the suite effects as neutral or worse. These were the worse ratings of any BOS.

	Very Negative	Somewhat Detrimental	Neutral	Reasonably Positive	Very Positive	Can't Evaluate	No Opinion
CSS	10	13	12	3	1	31	3
	10	10	22	8	1	17	5

TEM/OPS. The TEM portion of the system provided a very high quality digital mapping and terrain analysis capability to the MSF staff. It was also capable of transmitting terrain information to other systems (e.g., Phoenix). However, because the system would try to transfer the entire digital data base for the geographic area concerned, huge files (up to 33 megabytes) were created to transfer. This transfer would completely degrade LAN performance. The OPS portion of the system provided a good tool to plan engineer work and to compare engineer requirements with capabilities.

NET. The NET provided a useful digital map display, but it lacked the terrain analysis capability to adequately support the evaluation of tactical communications networks in a timely manner. The capability to assess communications network connectivity, loading, and routing is unknown because the NET was a standalone system, and the communications network used during the SIMEXes and PW were commercial LANs.

OPLOG Planner. This system provided the only automated forecasting tool available to the logistics elements of the MSF during the SIMEXes. The system was fairly user friendly. However, the student users had to develop their own database to support the operation. This took most of the users' time during the first two SIMEXes.

LPXMED. This software program provided the only medical services forecasting capability for the MSF during PW. It performed as desired and was fairly user friendly.

Specific Training Simulation Systems. This section presents observations concerning the individual training simulation systems.

CBS. The CBS system provided a low resolution simulation to exercise a division level staff. Because of the division level training mission which CBS meets as the Army's premier staff training system, it was not designed with the fidelity to fully represent the actions of all the forces being exercised in the SIMEXes and PW. A drawback to using CBS for the experiment was that operators still had to manually insert the actions that the units executed, when that information had already been planned, coordinated, and directed through separate stand-alone or networked functional area information systems in the digitized MSF. As shown prior in the connectivity diagram, most of the functional area systems did not interface with CBS in this experiment.

CBS required contractor personnel as CBS operators. Because these individuals were not adequately familiarized with either the MSF or DBS concepts, the support to the staff was adversely affected to some extent. Also affecting the degree to which CBS supported the evaluation of the MSF and DBS concepts, was the fact that CBS lacked the flexibility to allow multifunctional workstation tasking. Currently CBS workstations are limited to single functional area capabilities, appropriately corresponding to the current division structure. However, the DBS concept required multifunctional staff, which CBS was not designed to support. For example, a user at a CSS workstation could not execute maneuver or fire support functions from the same workstation, even though, as an example, that user may also have had responsibility for command and control of those functions in the sanctuary.

BICM. The BICM met requirements. BICM provided hundreds of sensor reports to the ASAS workstations.

UAV/JSTARS/HRSS. This system was not available to the MSF until the third SIMEX. It provided a realistic simulated imagery input to the intelligence, aviation, field artillery, and maneuver brigade staffs. This "imagery" was based on flying UAVs over simulated CBS terrain to locate and identify enemy units. The coverage of JSTARS over this terrain was also provided.

This system showed the value of such imagery intelligence systems and contributed to the MSF's success in deep operations. However, the system was somewhat complex and user unfriendly, and the simulated locations of specific vehicles and targets in UAV/JSTARS/HRSS did not match the aggregate modeled locations in CBS.

CSSTSS. This simulation system was not functional until PW. It did provide an interface between the CBS simulation and LAD. It took aggregated logistics data from CBS and generated the detailed logistical data necessary to exercise logistics within the PW scenario. However, there were data mapping problems which created inaccurate data in LAD, causing loss of users' confidence. As with most of the other systems in the experiment, user friendliness was lacking.

Materiel development. Phoenix was undergoing prototype development throughout the experiment. Phoenix was continuously upgraded as new capabilities were developed or changed as problems were fixed. This process was a training challenge for the MSF Commander and the BCE students. This process of prototyping created ripple effects through the entire suite of software without being readily detected. Because the software was not mature, contractor personnel were constantly on site and called on to help users recover from failures, to troubleshoot the system, or to explain system changes to the users. The users were then responsible to remember the current correct procedures. The original Phoenix users manual was outdated within one month of issue to the students and it was never updated.

Organization

Simply inserting technology into an organization does not change how an organization is structured or how it works. The thrust of this experiment was to flatten the headquarters to exploit information technology in a knowledge-based force. There was a conscious effort to change the organization and processes of the MSF command and staff, based on these information technologies. A detailed discussion of the impacts of materiel on staff organization and process is presented in the TRAC technical monograph, *"Staff Organization and Processes for the Digitized Division."*

Soldiers

The main soldiers issue concerned the efficiency and effectiveness of man/machine interfaces. User friendliness was a problem for most of the systems examined. The software programs were apparently cumbersome and difficult to use for the majority of the BCE. Regardless of the level of difficulty associated with the use of advanced technology systems, the technology surveys showed that competency in all technologies increased through the BCE. Experience with these complex systems somewhat mitigated the inherent problems associated with using them.

The results of the leader competency survey revealed two important findings for the future force. First, decisionmaking skills in this knowledge-based environment were assessed as highly important and difficult to acquire. The BCE students assessed the difficulty of acquisition even higher at the end of the course than at the beginning. Interviews determined that this increased perception of the difficulty of acquisiton of this competency was based primarily on the students' realization of the information overload that will occur in this type of environment. These advanced information technologies must mitigate this problem of information overload. Second, the use of available systems was initially assessed as both highly important and difficult to acquire. However, their perceptions of the difficulty of acquisition declined over the BCE. This indicates that the experience with the systems in the experiment was a mitigating factor in the difficulties users face with new, advanced technology systems. Two other TRAC technical monographs address the topics discussed above. These are *"Mobile Strike Force - Literacy Assessments: Implications for Force XXI"* and *"Leader Competencies: Implications for Force XXI."*

Conclusions

The battle command information technology capabilities collectively affected division staff processes and organization in several ways. First, although the technology suite provided enhanced situational awareness to the MSF, the lack of seamless connectivity diminished the potential of the data available to the MSF, primarily with regard to timeliness. This lack of connectivity also precluded the study team from completely assessing this issue. Second, communications among the command and staff were complicated by the proliferation and limitations of information technology. VTCs, ATCs, phones, radios, and e-mail provided many communications means for the MSF - but these means were generally lacking in quantities or maturity of features, and taken together often confounded, rather than helped the BCE. Third, information overload adversely affected the MSF to a significant degree, demonstrating the need for data filters throughout the system to help to develop the relevant common picture. Finally, these capabilities were generally provided by systems characterized as lacking user friendliness, which was frustrating.

Computer-assisted wargaming could not be assessed, except that the absence of such automated support was notable by most key experiment participants. No observation indicated that the requirement for a computer-assisted wargaming tool is not still valid.

The experiment results strongly implied that fully integrated command, control, and intelligence systems better achieve a relevant common picture of the battlefield than "stove-piped" systems. The suite of systems, far from fully integrated, provided enhanced situational awareness to the MSF. Whenever there was any degree of integration accomplished, the effect on battle command was positive. The myriad of ABCS systems must be fully integrated to support the force commander with a relevant common picture. These systems must be integrated to achieve the requisite timeliness implied by relevancy.